VOC Capture and Destruction Efficiency Test Protocol

Ferrara Candy Company
Four Permanent Total Enclosures and
Catalytic Oxidizer System
Forest Park, Illinois
Protocol No. M161403

mostardi platt

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Protocol Submittal Date
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Submitted By

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GENERAL INFORMATION APPENDED:

1.0 INTRODUCTION

An emission compliance test program to determine the volatile organic compounds (VOC) capture and destruction efficiency and emission rate of the four existing Permanent Total Enclosures (PTEs) and the Catalytic Oxidizer System which controls Candy polishing process emissions will be conducted at the Ferrara Pan Candy Company in Forest Park, Illinois. All testing will be performed as described in the *Code of Federal Regulations*, Title 40, Part 60, Appendix A (40CFR60), Methods 1, 2, 3, 4, 18 (methane only, if applicable), 25A, and 40CFR, Part 51, Appendix M, Method 204, and ASTM E337-02 and the latest revisions thereof. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, USEPA 600/4-77-027b will be used to determine the precise procedures.

Project Contact Information		
Location	**Address**	**Contact**
Facility Representative	Ferrara Candy Company 2300 Maywood Drive Bellwood, IL 60104	Mr. Craig Caswell Regulatory Engineer (708) 224-0040 Craig.caswell@ferrarausa.com
Testing Company Representative	Mostardi Platt 888 Industrial Drive Elmhurst, Illinois 60126	Jeffrey M. Crivlare Senior Project Manager (630) 993-2100 jcrivlare@mp-mail.com

2.0 PROCESS DESCRIPTION AND OPERATING RATES

<u>Process Description and Rates</u>

The candy polishing process is a batch process in which candy centers are placed into ovate rotating pans where the pans are filled with a pre-weighed amount of centers. The typical batch process from center addition to pan unloading takes approximately one hour. After the centers are added, the chocolate or other “grossing” raw materials are added by hand and until the desired size of the candy pieces is obtained. Once the candy is sized properly, a pre-measured amount of confectioner’s glaze is added by hand. Once added, the pans rotate until the glaze is dried and the batch is then finished and ready for packaging.

The glazes are either vegetable/mineral oil or solvent-based. The solvent-based glazes consist mainly of solids dissolved in ethanol, ethyl acetate, or other minor food grade solvents that evaporate to leave a hardy, shiny coating on the candy. Vegetable/mineral oil-based glazes act in a similar fashion but dry more slowly.

Candies polished include chocolate, jelly beans, and other soft candies as described below:

<u>Chocolate Panning/Polishing</u> usually starts with almond, peanut, or raisin centers rather than sugar centers as is used for the jelly beans and soft candy panning process. Steam heated chocolate is sprayed or poured onto the centers as the pans rotate and conditioned air solidifies the chocolate as the centers are covered and increased in size. After the correct amount of chocolate is applied, a confectioner’s glaze, which may contain VOCs, is hand poured in pre-measured amounts once per batch onto the candy pieces. The solvent portion of the glaze evaporates and leaves a hard, glossy shine (e.g., polish) to the candy pieces. The chocolate

panning/polishing process in conducted in permanent total enclosures (PTEs) and VOC emissions are collected and routed to a catalytic oxidizer for destruction.

Once the candy glaze solidifies, the batch is complete and the candy pieces are removed from the pans, placed onto trays and transferred to packaging.

Soft Candy Panning/Polishing usually starts with “grossed” candy centers and other ingredients such as sugar, colors, and flavors which are added to build up a shell around the centers. As a final step, a confectioner’s glaze, which may or may not contain VOCs, is added once per batch by hand in pre-measured amounts as a protective coating and decorative layer. The soft candy panning/polishing process in conducted in a PTE and VOC emissions are collected and routed to a catalytic oxidizer for destruction.

As with the chocolate polishing process, once the glaze solidifies the batch is completed and the candy pieces are removed from the pans, placed onto trays and transferred to packaging.

Stack Testing Operating Parameters
During the stack testing program, all polishing pans will be in operation in the PTEs. The testing will be conducted during the entire batching process from center addition through glaze application and drying. Each pan will polish a typical batch size of approximately 250 lbs of candy pieces and use the confectioner’s glaze in the prescribed pre-measured quantity for each pan which is typically about 8 ounces of glaze.

3.0 TEST REQUIREMENTS

The following table presents a list of the pollutants to be tested at each emission source and the applicable rules or regulations for each emission test:

TEST PARAMETERS		
Emission Point	**Pollutant Tested**	**Method/Regulation Citation**
Catalytic Oxidizer Inlet	VOC	USEPA Methods 1, 2, 3, 4, 18 (methane only, if needed), 25A, 40CFR60, Appendix A and ASTM E337-02
Catalytic Oxidizer Stack	VOC	USEPA Methods 1, 2, 3, 4, 18 (methane only, if needed), 25A, 40CFR60, Appendix A and ASTM E337-02
Permanent Total Enclosures	VOC	USEPA Method 204, 40CFR51, Appendix A.

VOC Destruction Efficiency Tests

Three (3) one (1)-hour VOC test runs will be performed simultaneously at the catalytic oxidizer inlet and stack in accordance with United States Environmental Protection Agency (USEPA) Methods 1, 2, 3, 4, 18 (methane only, if applicable), and 25A, Title 40, *Code of Federal Regulations*, Part 60, Appendix A, and ASTM Method E337-02 wet bulb/dry bulb procedures.

If required, one integrated Tedlar bag sample will be taken during each test run and analyzed off-site for methane concentrations by gas chromatograph/flame ionization detector for total gaseous non-methane hydrocarbon determinations.

Destruction Efficiency (DE) will be calculated as follows:

$$DE = \frac{\text{Oxidizer In VOC lb/hr} - \text{Oxidizer Out VOC lb/hr}}{\text{Oxidizer In VOC lb/hr}} \times 100$$

Oxidizer Test Locations				
Location	**Dimensions**	**Area**	**Test Parameter**	**Number of Sampling Points**
Oxidizer Inlet	30 Inches	4.909 Square Feet	Volumetric flow	16
Oxidizer Outlet	31 inches	5.241 Square Feet	Volumetric flow	16

4.0 SPECIFIC TEST PROCEDURES

Detailed test procedures are appended. Three complete test runs will be performed for each parameter in accordance with the following USEPA methods.

1. Volumetric flow will be determined utilizing USEPA Methods 1 and 2, 40CFR60 in conjunction with each emission test. A pretest and posttest volumetric flow will be performed and averaged for each VOC gaseous test run.

2. Oxygen (O_2) and carbon dioxide (CO_2) content of the gases will be determined by USEPA Method 3, 40CFR60 during each test run.

3. Moisture content of the gases will be determined using USEPA Method 4, 40CFR60 and/or ASTM E337-02 during each volumetric flow test run.

4. Total hydrocarbon emissions will be determined in accordance with USEPA Method 25A, 40CFR60. Each test will be one hour long with the emissions determined as ppm propane.

5. If required, one integrated Tedlar bag sample will be taken during each hour of testing at each test location during each test run and analyzed off-site for methane concentrations by gas chromatograph/flame ionization detector for total gaseous non-methane hydrocarbon determinations.

6. The four Permanent Total Enclosures (PTE's) will be evaluated to verify that they meet the criteria of USEPA Method 204, 40CFR51, Appendix M.

7. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, USEPA 600/4-77-027b is used to determine the precise procedures.

5.0 TEST PROGRAM SCHEDULE

Refer to plant submittals for specific dates.

Day	Activity	On-Site Hours
1	Set-up equipment and evaluate four PTEs.	8
2	Perform VOC destruction efficiency test runs.	8

All project days are considered weekdays and are scheduled between the hours of 7:00 a.m. and 6:00 p.m., unless otherwise stated.

6.0 PROJECT PERSONNEL

1 Project Manager
2 Test Engineers
1 Test Technician

7.0 PLANT REQUIREMENTS

Mostardi Platt must be supplied with the following items in order to complete this test program:

1. Safe access to test positions.
2. Electrical power 110 V, 20 A service at the test locations.
3. Test ports cleaned and loose prior to arrival of test crew.
4. Any scaffolding required to perform the tests.
5. Sufficient lighting at the test site.
6. Plant or pollution control equipment-operating data, if required for report.
7. Washroom facilities for use by members of the test crew.
8. Steady load during test period.
9. Communication between the test location and the control room.
10. Parking location to place Mostardi Platt mobile trailer within 200 feet of sampling locations with access to multiple 110 V, 15 amp, 60-cycle, 220 V, 50 amp, 60-cycle circuits, or a 480 V welding receptacle.
11. Oxidizer operating temperatures should be recorded during testing and provided to test crew for final report.

8.0 TEST PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program will be performed as described in the Title 40, *Code of Federal Regulations*, Part 60, Appendix A (40CFR60), Methods 1, 2, 3, 4, 25A, and, 40CFR51, Appendix M, Method 204, and ASTM E337-02 and the latest revisions thereof. Where applicable, the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume III, Stationary Source Specific Methods, United States Environmental Protection Agency (USEPA) 600/R-94/038c, September 1994 was used to supplement procedures.

Volumetric Flowrate Determination

In order to determine the VOC emission rates on a lb/hr basis, the gas velocities and volumetric flowrates are determined using reference Method 2.

Velocity pressures are determined by traversing the test locations with S-type pitot tubes. Temperatures are measured using a K-type thermocouple with a calibrated digital temperature indicator. The molecular weight and moisture content of the gases are determined to permit the calculation of the volumetric flowrate. Sampling points utilized are determined using Method 1, 40CFR60.

Oxygen (O_2)/Carbon Dioxide (CO_2) Determination

O_2 and CO_2 gas content are determined at the test locations in accordance with Method 3, 40CFR60. This method collects samples in a grab or integrated manner and analyzes the samples using a Fyrite gas analyzer. Several passes of the gas are made during each run to ensure a stable reading. Mandatory leak checks are performed prior to and following each use. Chemicals are changed frequently and inspected for reactivity prior to each use.

Moisture (H_2O) Determination

Determining the moisture content in the gas stream is necessary to calculate the stack gas volumetric air flow on a dry basis and the VOC emission rate in lb/hr. For this purpose, Mostardi Platt uses two methods.

1. American Standard Testing Method (ASTM) Method E337-02 reapproved 2002, wet bulb/dry bulb measurements are made at the oxidizer inlet and oxidizer outlet if temperatures allow during each VOC sampling run and the water vapor content is calculated as follows:

$$Bws = \left[\frac{e' - AP(t - t')}{P}\right]$$

where:

e' = saturated vapor pressure of water, in. Hg, at the wet bulb temperature, t'
A = $3.67 \times 10^{-4} [1 + 0.00064(t' - 32)]$
P = absolute pressure, in. Hg, in duct
t = dry bulb temperature, °F
t' = wet bulb temperature, °F

2. At the oxidizer outlet, if temperatures dictate, *An Alternative Method for Stack Gas Moisture Determination*, written by John Stanley and Peter Westlin, August 1978, Emission Measurement Branch, USEPA, is utilized. The sampling equipment is the same as specified for the moisture approximation method in Reference Method 4, except for the addition of two impingers, one containing silica gel.

   Approximately 15 mls of water are added to each of the first two impingers and the third is left empty. An impinger containing approximately 15 grams of silica gel and a glass-wool-packed outlet is attached following the third impinger. The entire impinger train, excluding the inlet and outlet connectors, is weighed to the nearest 0.05 gram. The impingers are placed in an ice bath to maintain the sampled gas passed through the silica gel impinger outlet below 68°F in order to increase the accuracy of the sampled dry gas volume measurement. Each sample is extracted through a stainless steel probe at a constant sample rate of between one to four liters per minute, which is maintained during the course of the other simultaneous reference method sampling. After each run, a leak check of the sampling train is performed at a vacuum greater than the sampling vacuum to determine if any leakage had occurred during sampling. Following the leak check, the impingers are removed from the ice bath and allowed to warm. Any condensed moisture on the exterior is removed and the train reweighed.

Volatile Organic Compound (VOC) Determination

The Method 25A sampling and measurement system meets the requirements for stack sampling of VOCs set forth by the United States Environmental Protection Agency (USEPA). In particular, it meets the requirements of USEPA Reference Method 25A, “Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer,” 40CFR60, Appendix A. This method applies to the measurement of total gaseous organic concentration of hydrocarbons. With this method, gas samples are extracted from the sample locations through heated Teflon sample lines to the analyzers.

The flame ionization detectors (FIDs) to be used during this program are VIG High-Temperature Total Hydrocarbon Analyzers. They are highly sensitive FIDs that provide a direct reading of total organic vapor concentrations with linear ranges of 0-10, 100, 1000, and 10,000 ppm by volume. The instruments are calibrated using ultra-zero air and propane in air EPA Protocol standards. The calibrations are performed before and after sampling with calibration checks performed between each test run. Sampling is conducted continuously for three one-hour periods for VOC destruction efficiency tests. Sample times and locations are logged simultaneously on data loggers. Final concentrations are determined by subtracting methane from the Method 18 analysis, if applicable, from the inlet and outlet concentrations.

Calculations are performed by computer or by hand. An explanation of the nomenclature and calculations along with the complete test results is included in the appendix. Also appended are calibration data and copies of the raw field data sheets.

Enclosure Evaluation Determination

A 100% Permanent Total Enclosure (PTE) must meet four (4) specific engineering criteria. The criteria are described in USEPA Method 204, 40CFR51, Appendix M. A summary of these items and the evaluation technique used are described below.

Natural Draft Openings (NDO) Distance to Emitting Point

Criteria: All NDOs such as open doorways, windows, etc. must be at least four equivalent NDO diameters from the nearest potential VOC emission point.

Technique: The dimensions of all NDOs and potential emission points are measured. The calculated NDO equivalent diameters are compared to the emission point distances measured.

Total NDO Area

Criteria: The area of all NDOs divided by the total area of all walls, floor and ceilings in the enclosure (called the “NEAR” ratio in the procedure) must not exceed 0.05.

Technique: Actual measurements are used to determine a composite surface area of the room and the NDOs and the NEAR ratio is determined.

Velocity of Air Flow through NDOs

Criteria: The calculated face velocity through the NDOs must be greater than 200 fpm. This is defined as the total exhaust volume (in scfm), less make up air, divided by the area of all NDOs (in square feet).

Technique: The composite area of the NDOs (as determined above) is used along with the measured net exhaust volume, as determined by USEPA Method 2, 40CFR60, Appendix A, of the enclosure to calculate the face velocity or alternately, the static pressure of the enclosure is measured to determine if it meets the $\geq$ 0.007 inches H_2O criteria.

Direction of Air Flow through the NDO

Criteria: The direction of air flow through all NDOs must be into the enclosure.

Technique: Smoke tubes are used at each NDO to measure the direction of the air flow. A record of this data will be included on the scale drawing.

9.0 QUALITY ASSURANCE PROCEDURES

Mostardi Platt recognizes the previously described reference methods to be very technique-oriented and attempts to minimize all factors which can increase error by implementing its Quality Assurance Program into every segment of its testing activities.

Shelf life of chemical reagents prepared at the Mostardi Platt laboratory or at the jobsite does not exceed those specified in the above mentioned methods. In addition, those reagents having a shelf life of one week are prepared daily at the jobsite. When on-site analyses are required, the same person performing the analysis performs all reagent standardization daily.

Dry and wet test meters are calibrated according to methods described in the *Quality Assurance Handbook for Air Pollution Measurement Systems*, Sections 3.3.2, 3.4.2 and 3.5.2. Percent error for the wet test meter according to the methods is less than the allowable error of 1.0%. The dry test meters measure the test sample volumes to within 2% at the flowrate and conditions encountered during sampling.

Calibration gases are EPA Protocol gases.

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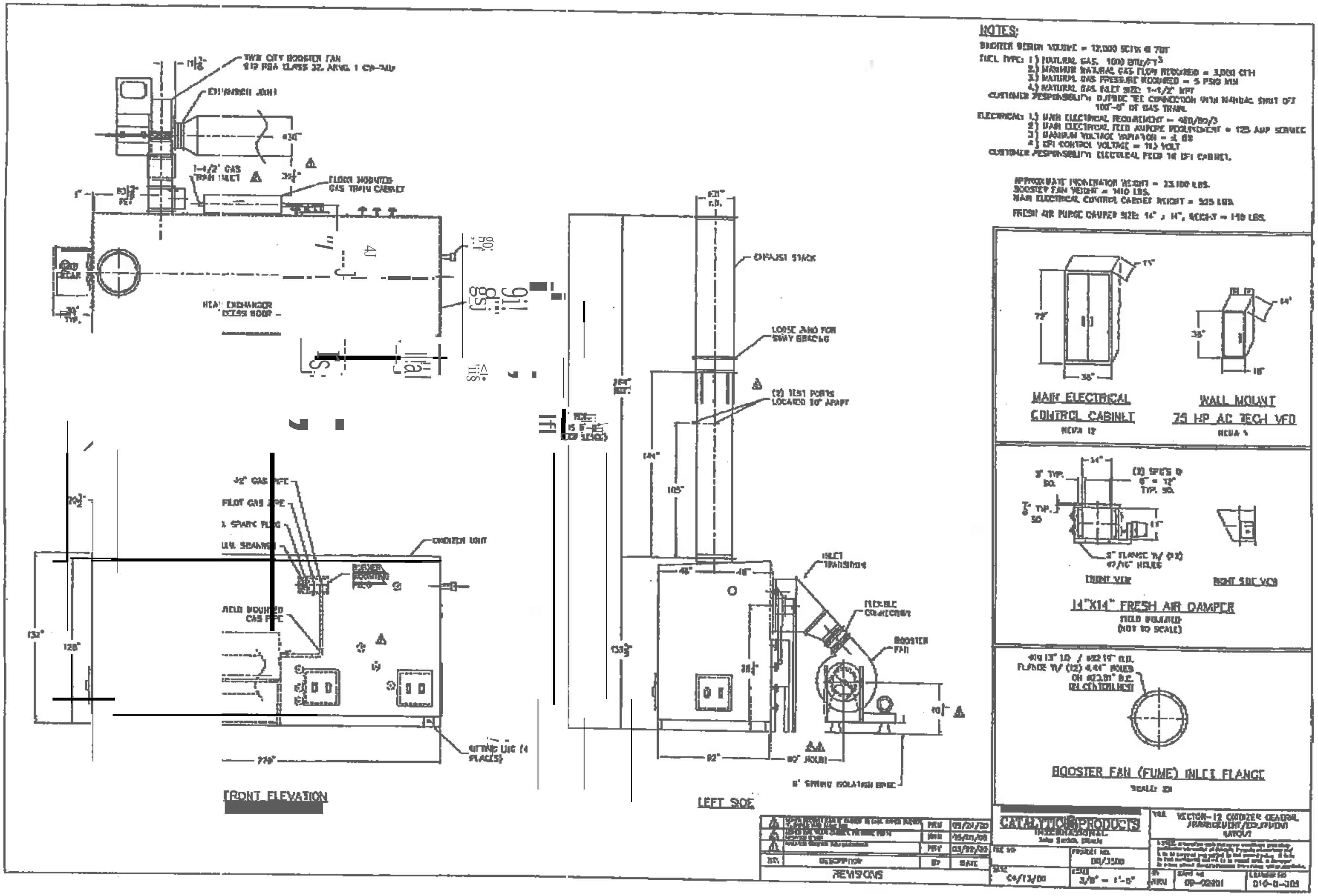
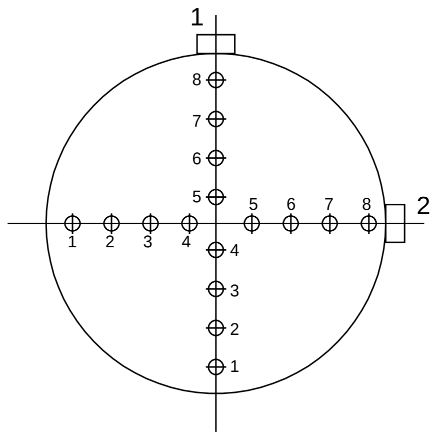
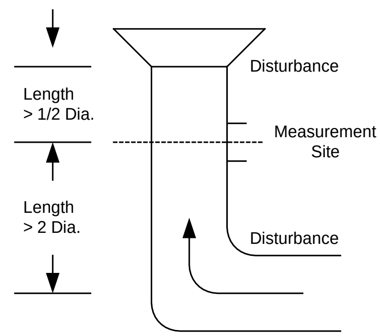
APPENDIX


NOTES:
EXHAUST STACK
LOOSE AND FOR SWAY BRACING
(2) TEST PORTS LOCATED 10" APART
INLET TRANSITION
FLEXIBLE CONNECTION
BOOSTER FAN
OXIDIZER UNIT
FIELD MOUNTED GAS PIPE
PILOT GAS PIPE
FRONT ELEVATION
LEFT SIDE
MAIN ELECTRICAL CONTROL CABINET
NEMA 12
WALL MOUNT
75 HP AC TECH VFD
FRONT VIEW
RIGHT SIDE VIEW
14"X14" FRESH AIR DAMPER
FIELD MOUNTED
(NOT TO SCALE)
BOOSTER FAN (FUME) INLET FLANGE
CATALYTIC PRODUCTS INTERNATIONAL
REVISIONS
DESCRIPTION
DATE

EQUAL AREA TRAVERSE FOR ROUND DUCTS

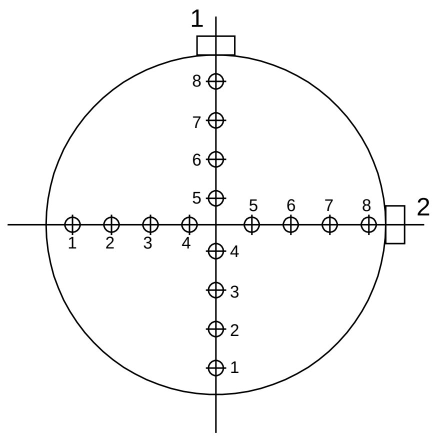


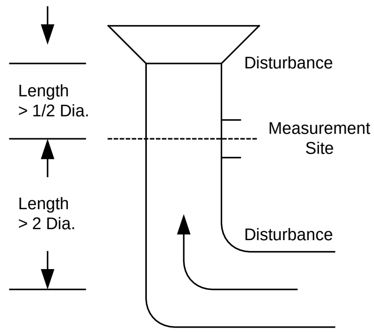


Job:	Ferrara Pan Candy Company
	Forest Park, Illinois
Test Location:	Catalytic Oxidizer Inlet
Stack Diameter:	30 inches
Stack Area:	4.909 Square Feet
No. Points Across Diameter:	8
No. of Ports:	2


BORDEN'S

EQUAL AREA TRAVERSE FOR ROUND DUCTS





Job: Ferrara Pan Candy Company
Forest park, Illinois

Test Location: Catalytic Oxidizer Outlet

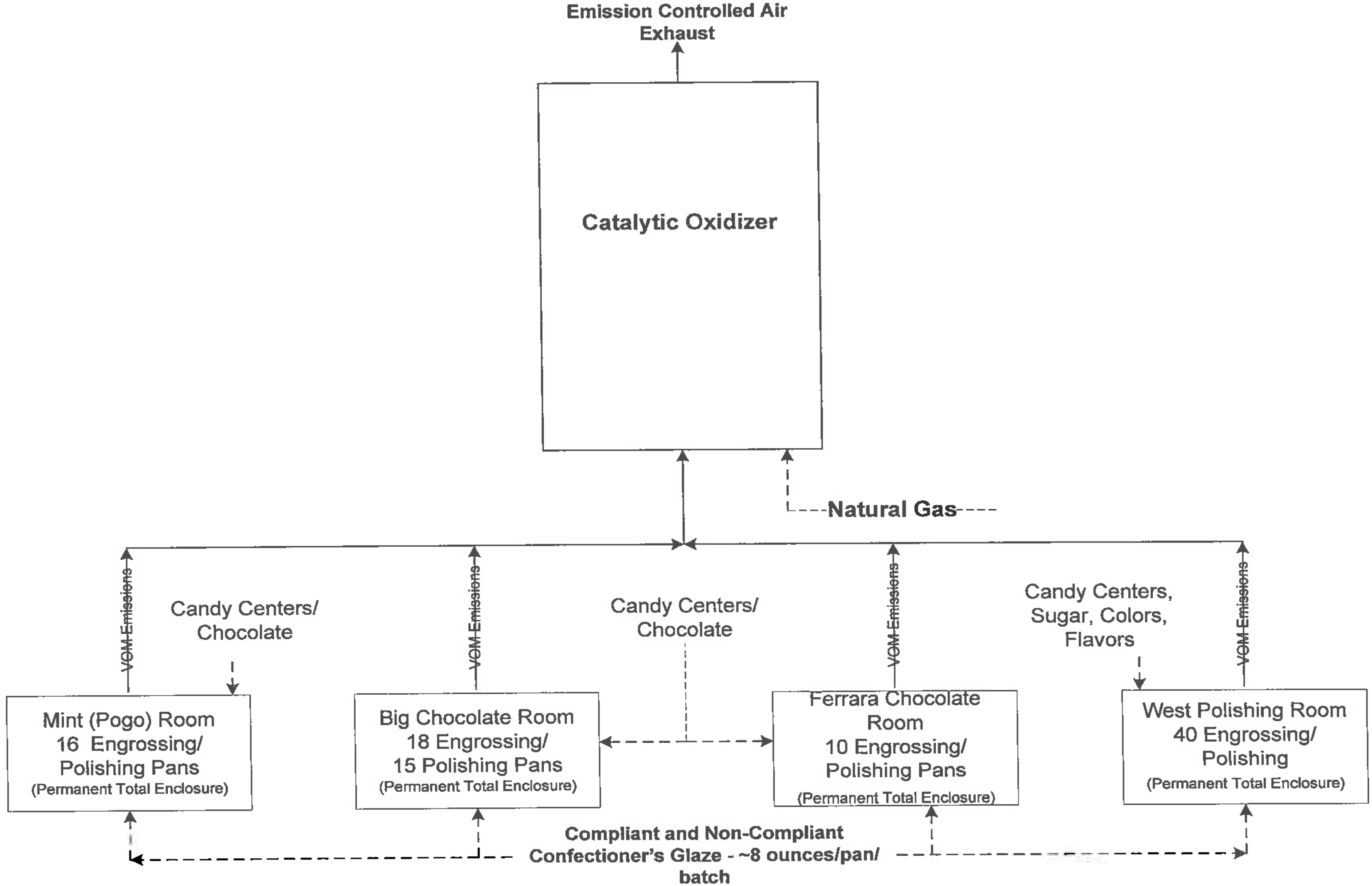
Stack Diameter: 31 Inches

Stack Area: 5.241 Square Feet

No. Points Across Diameter: 8

No. of Ports: 2

Process Flow Diagram
Catalytic Oxidation of Candy Polishing VOMs



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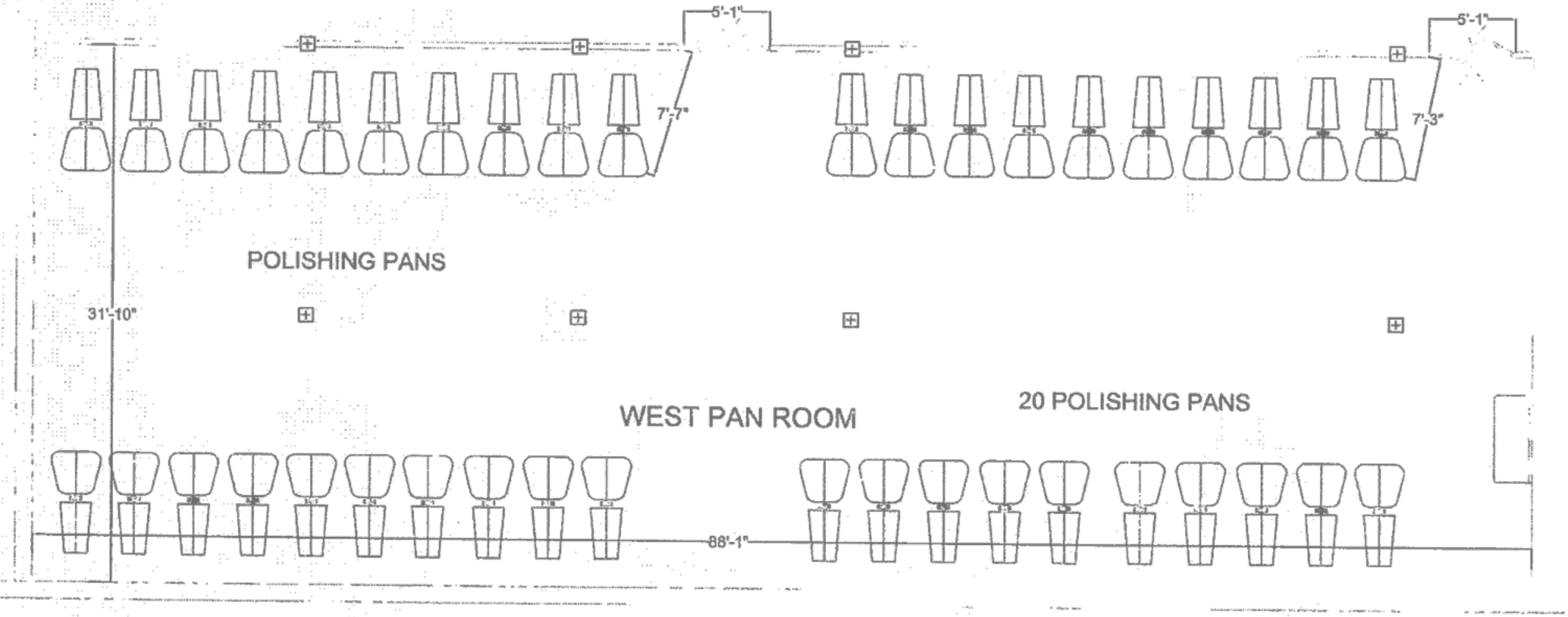
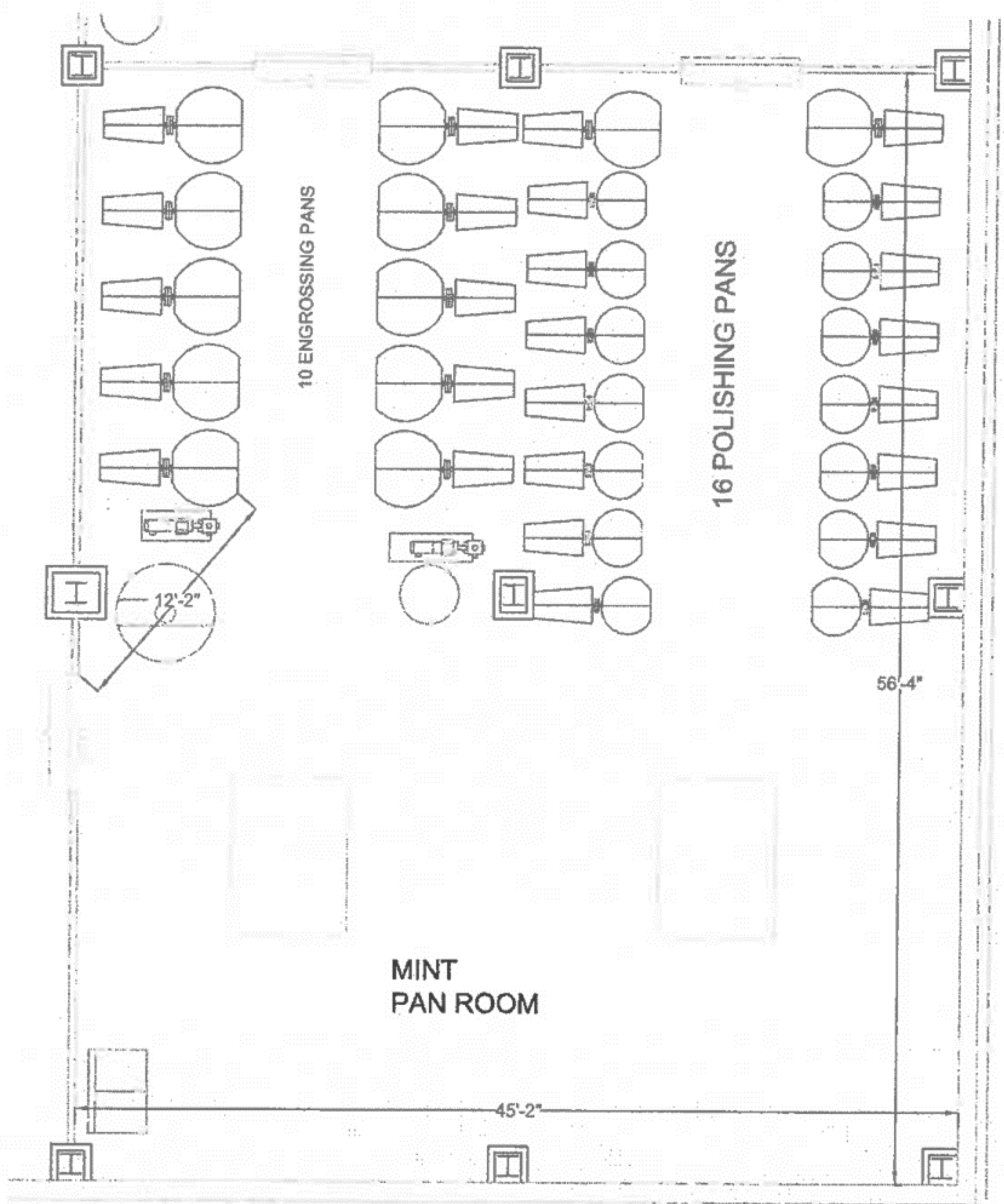
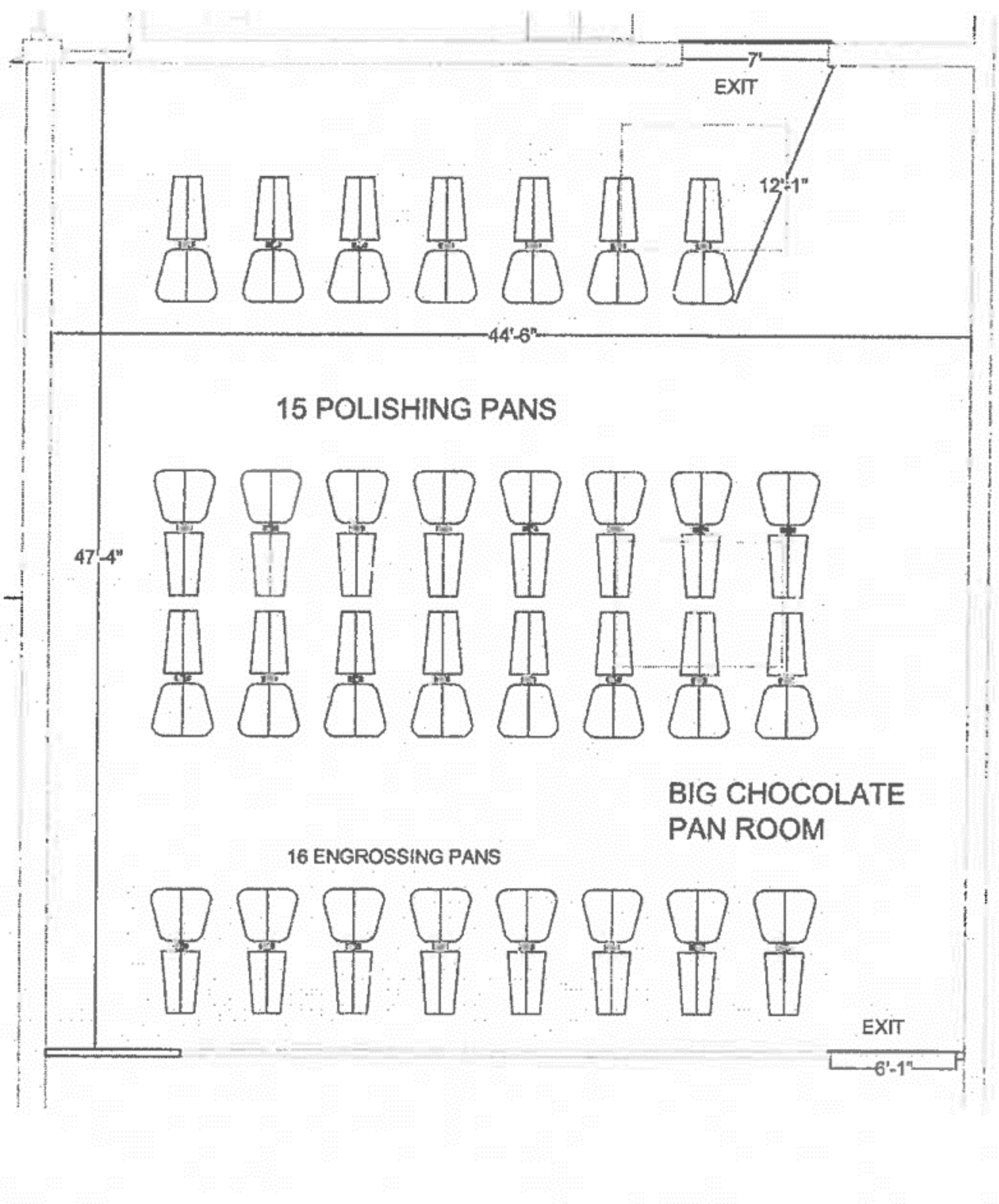
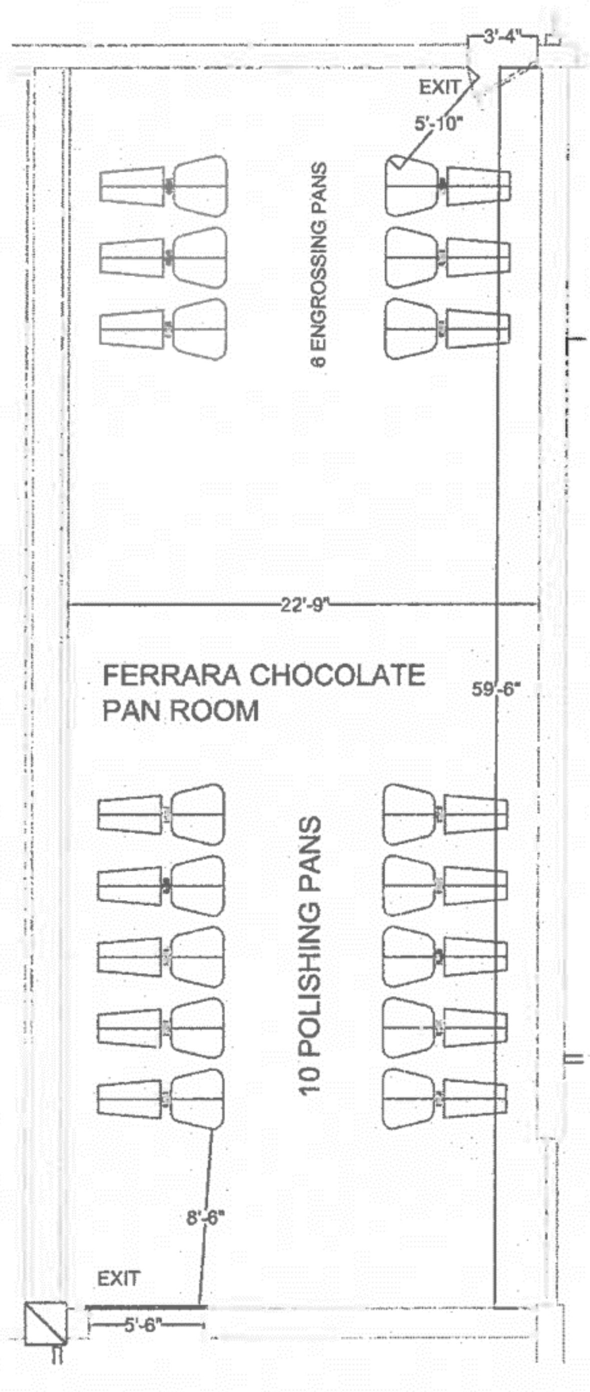
Ferrara Candy Company
Forest Park, Illinois

Date: February 2, 2016	Project #: M166006
APPROXIMATE SCALE: NOT APPLICABLE	FILENAME: Polishing Process


5'-1"
5'-1"
7'-7"
7'-3"
POLISHING PANS
31'-10"
WEST PAN ROOM
20 POLISHING PANS
88'-1"

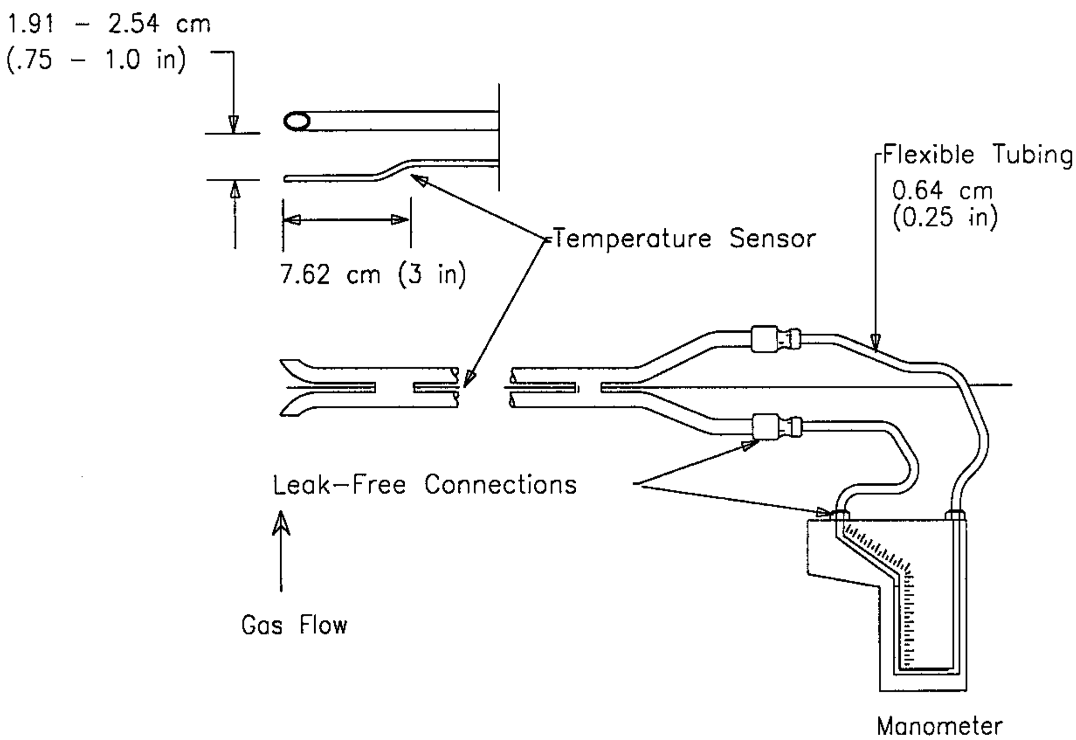

10 ENGROSSING PANS
16 POLISHING PANS
12'-2"
56'-4"
MINT
PAN ROOM
45'-2"


7'
EXIT
12'-1"
44'-6"
15 POLISHING PANS
47'-4"
BIG CHOCOLATE
PAN ROOM
16 ENGROSSING PANS
EXIT
6'-1"

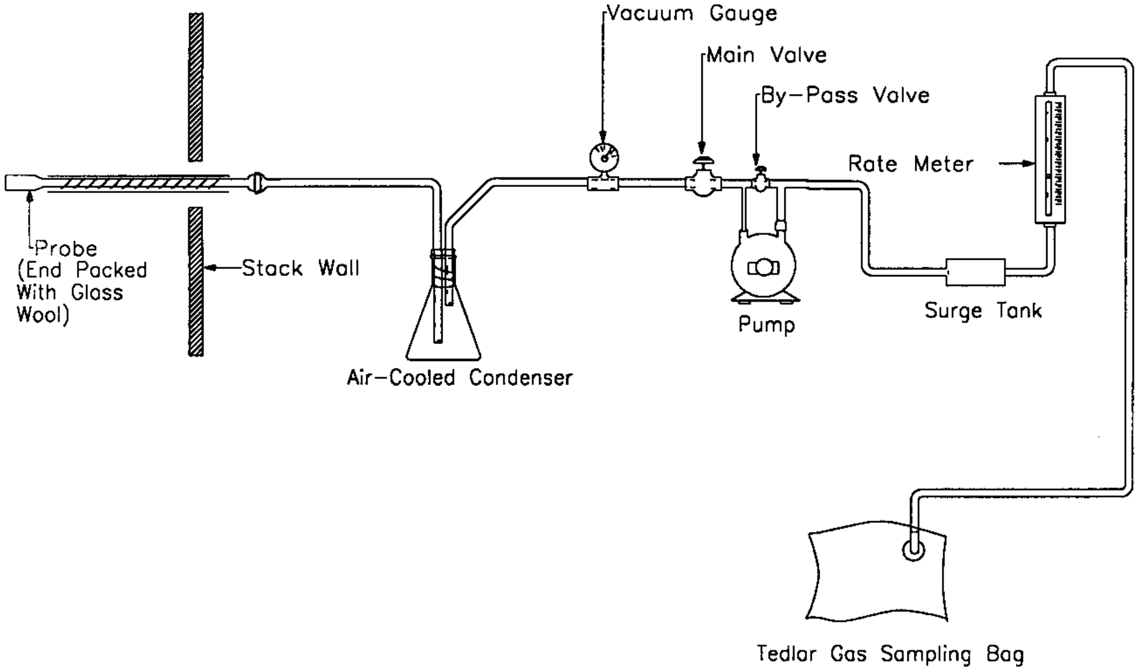


3'-4"
EXIT
5'-10"
8 ENGROSSING PANS
22'-9"
FERRARA CHOCOLATE
PAN ROOM
59'-6"
10 POLISHING PANS
8'-6"
EXIT
5'-6"

USEPA Method 2 - S-Type Pitot Tube Diagram

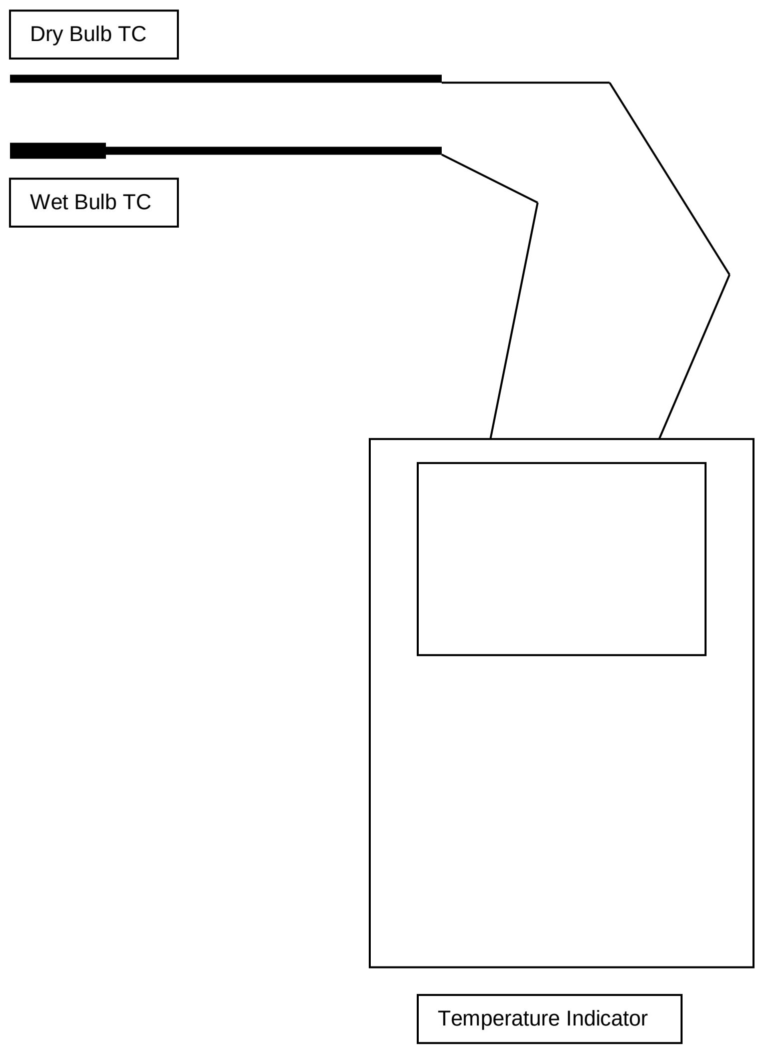


USEPA Method 3 - Integrated Oxygen/Carbon Dioxide Sample Train Diagram utilizing Fyrite Gas Analyzer

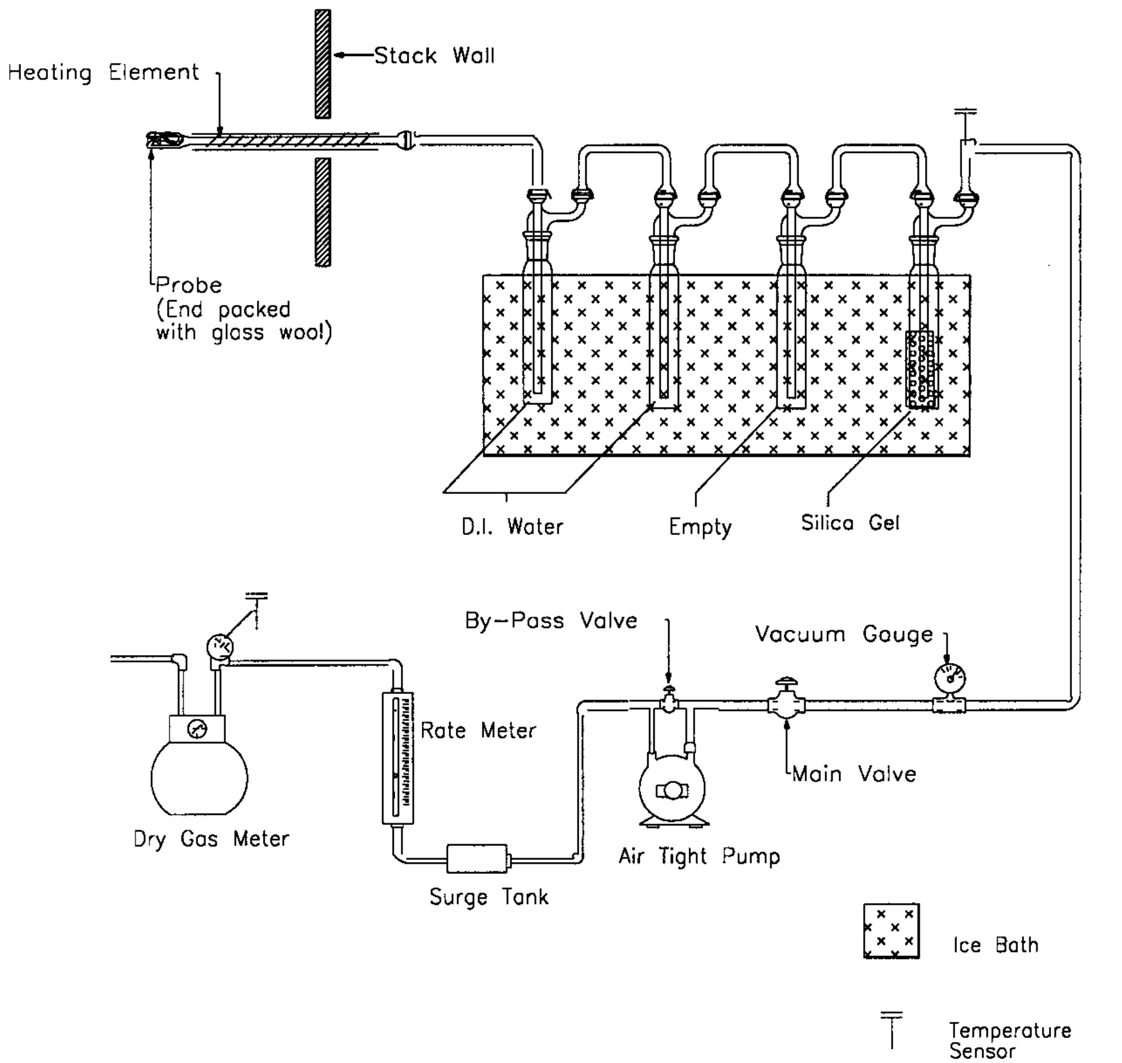


Moisture Determination

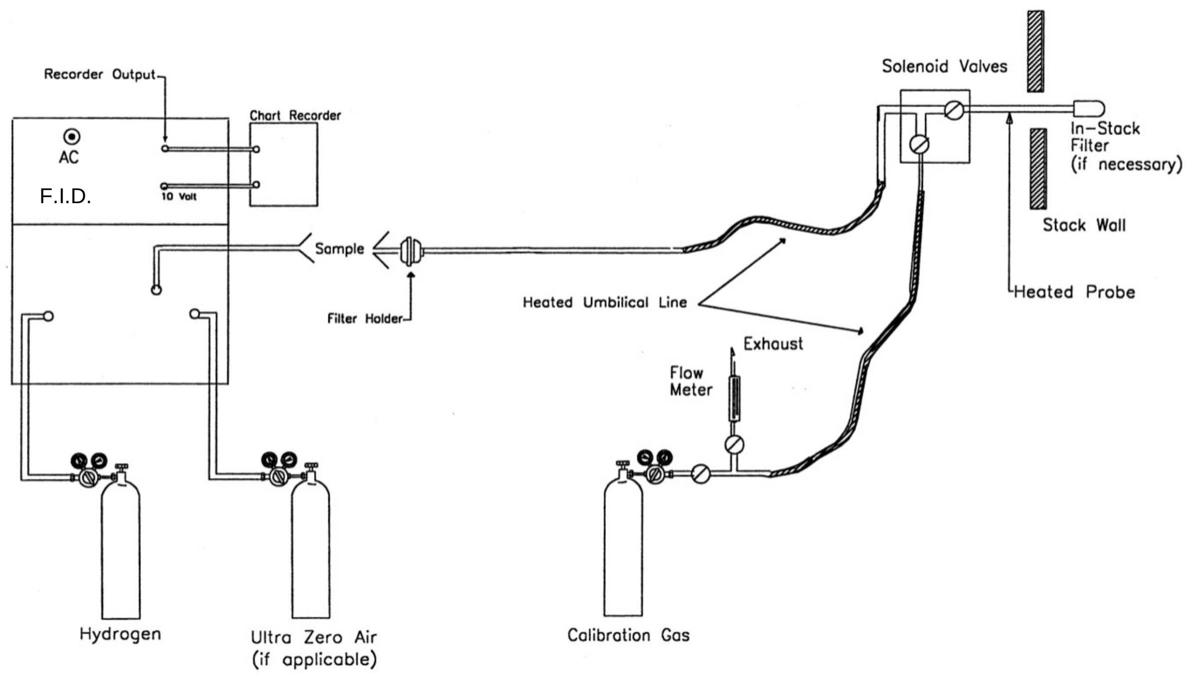
ASTM Method E337-02, Reapproved 2002



USEPA Method 4 - Moisture Sample Train Diagram



USEPA Method 25A -Total Gaseous Organic Compound Sample Train



Volumetric Flow Rate Determination Field Data Sheet

Project Number: ______________________ Date: ______________________
Client: ______________________ Test Number: ______________________
Test Location: ______________________ Start Time: ______________________
Source Condition: ______________________ End Time: ______________________
Test Engineer: ______________________ Test Tech: ______________________

Duct Diameter ______ ft Upstream Disturbance, Diameters ______
Flue Area _________ ft^2 Downstream Disturbance, Diameters ______
Port Length ______ “ Pitot ID______ Pitot Coefficient (C_p) _______
P_{bar}_______ ″Hg CO_2 % ______ Wet Bulb Temp ______ Leak Checks
Static_____ ″H_2O O_2 % _______ Dry Bulb Temp _____ Pre _____
Static______ ″Hg N_2 % _____ B_{ws} _____ Post _____
P_s________ ″Hg Meter No.______

Port-Point #	ΔP	Temp. °F	$\sqrt{\Delta P}$	Null Point Angle, Degrees	Port-Point #	ΔP	Temp. °F	$\sqrt{\Delta P}$	Null Point Angle, Degrees
Average									

.44 x CO_2% + .32 x O_2% + .28 x N_2% = ______(Md)
(_________Md × ________1-Bws) + (18 ×_______Bws) = ______(Ms)

$$85.49 \times \_\_\_\_\_ Cp \times \sqrt{\frac{(\_\_\_\_\_\_\_\_\_)Ts\ °R}{\_\_\_\_\_ Ms \times \_\_\_\_\_ Ps}} \times \_\_\_\_\_ \sqrt{\Delta P} = \_\_\_\_\_\ ft/sec\ (Vs)$$

______ Vs × ______ Flue Area × 60 = _______________acfm

$$17.647 \times \_\_\_\_\_\_ acfm \times \frac{Ps}{Ts\ °R} = \_\_\_\_\_\_\_\_\_\_\_ \text{ scfm x } 60 = \_\_\_\_\_\_\_\_\_\_\_ \text{ scfh}$$

MOISTURE FIELD DATA SHEET

ProjectName/Number:____Date:____________________
SamplingLocation:____
SourceCondition:____DryGasMeterNo.________________
MeterΔH____________________MeterY=____________________TestEngineer:___________________________

Test (Run) No. ______________ Barometric Pressure (P_{bar})__________________in. Hg
Gas Temperature ______________°F Static Pressure ________________________in. Hg

Orsat Analysis
__________%CO_2 __________%O_2

Clock Time 24 hour	Meter Volume (V_m) ft^3 or L (Circle One)	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (t_m) °F	Impgr. Outlet Temp °F
Total Vol.				
Average			(T_m)	°R

Condensate

________________mls (V_f)
-________________mls (V_i)
________________mls
× 0.04707 = _________

Silica Gel or Train

_________grams (W_f)
-_________grams (W_i)
_________grams
× 0.04715 = _________

________ft^3 [$V_{wc(std)}$] + _______ ft^3 [$V_{wsg(std)}$]
= __________ ft^3 [$V_{w(std)}$]

$V_{m(std)}$ = ___________ ft^3

Water Vapor, proportion by volume

Leak Check:

B_{ws} = ______________

Moisture correction factor:
1 - B_{ws} = ___________

Comments:

Test (Run) No. ______________ Barometric Pressure (P_{bar})__________________in. Hg
Gas Temperature ______________°F Static Pressure ________________________in. Hg

Orsat Analysis
__________%CO_2 __________%O_2

Clock Time 24 hour	Meter Volume (V_m) ft^3 or L (Circle One)	Meter Gage Pressure (ΔH) in. H_2O	Meter Temp. (t_m) °F	Impgr. Outlet Temp °F
Total Vol.				
Average			(T_m)	°R

Condensate

________________mls (V_f)
-________________mls (V_i)
________________mls
× 0.04707 = _________

Silica Gel or Train

_________grams (W_f)
-_________grams (W_i)
_________grams
× 0.04715 = _________

________ft^3 [$V_{wc(std)}$] + _______ ft^3 [$V_{wsg(std)}$]
= __________ ft^3 [$V_{w(std)}$]

$V_{m(std)}$ = ___________ ft^3

Water Vapor, proportion by volume

Leak Check:

B_{ws} = ______________

Moisture correction factor:
1 - B_{ws} = ___________

Comments:

$$V_{m(std)} = 17.64\, V_m Y \frac{P_{bar} + \frac{DH}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{w(std)}}{V_{w(std)} + V_{m(std)}}$$

Method 25A Field Data Sheet

Project: ______________________ Operator: ______________________
Client: ______________________ Source: 1. ______________________
Location: ______________________ 2. ______________________
Date: ______________________ 3. ______________________

Parameters	Location 1	Location 2	Location 3
Test 1			
Time			
VOC ppmv as			
Air flow, scfm			
VOC lbs/hr as			
Removal Efficiency, %			
Test 2			
Time			
VOC ppmv as			
Air flow, scfm			
VOC lbs/hr as			
Removal Efficiency, %			
Test 3			
Time			
VOC ppmv as			
Air flow, scfm			
VOC lbs/hr as			
Removal Efficiency, %			

METHOD 204 ENCLOSURE DATA SHEET

Project: ______________________________

Location: ______________________________

Date: ______________________________

Sketch enclosure, all ducts, NDOs and potential VOC emission points on accompanying page. Label all dimensions.

Enclosure Designation: ____________________ Process(es) Enclosed: ____________________

Control Devices (s): ____________________ ______________________________

NDO to VOC Emission Point

NDO	Dimensions	Area	Equivalent Diameter	VOC Emission Point	Distances		Pass/ Fail?
					Minimum	Actual	

$$\text{NDOs equivalent diameter} = \left(\frac{4 \times \text{area}}{\pi}\right)^{0.5}$$

$$\text{Minimum Allowed Distance} = 4 \times \text{Equivalent Diameter} \quad \text{(NDO)}$$

NDO to Exhaust (TTE only)

Exhaust Point	Dimensions	Equivalent Diameter	NDO	Dimensions	Equivalent Diameter	Distances		Pass/ Fail?
						Minimum	Actual	

$$\text{Equivalent diameter} = \left(\frac{4 \times \text{area}}{\pi}\right)^{0.5}$$

$$\text{Minimum Allowed Distance} = 4 \times \text{Equivalent Diameter} \quad \text{(NDO or Exhaust Point)}$$

METHOD 204 ENCLOSURE DATA SHEET (cont.)

Near Ratio [NDO Area/Total Enclosure Area]

NDO	Surface Area (FT^2)	Wall, Ceiling, or Floor Section	Surface Area (FT^2)
TOTAL NDO AREA=		**TOTAL ENCLOSURE AREA=**	

NEAR ratio:

$$\frac{NDO Area}{Enclosure Area} = \_\_\_\_\_\_\_\_\_\_\_\_$$

Pass/Fail?
____

Velocity of Air through NDO (Volumetric Flow Method)

Exhausted Air			Make Up Air	
Exhaust Point	**SCFM**	**Controlled? (Y/N?)**	**Make up point**	**SCFM**
TOTAL			**TOTAL**	

total NDO area - ________ ft^2

$$\frac{\text{Exhaust scfm - 1make up scfm}}{\text{NDO area } (ft^2)} = \_\_\_\_\_\_\_\_\_\_ \text{fpm}$$

fpm should be ≥ 200

pass/fail? _________________________

Or,
Velocity of Air through NDO (Pressure Differential Method)

Pressure Differential across the enclosure =_________inches H_20
Pressure difference $\geq$ 0.007 inches H_2O
pass/fail?_________

METHOD 204 ENCLOSURE DATA SHEET (cont.)

Direction of Air through NDO

Checked by Smoke Tubes

NDO No.	Normally		Direction of Air Flow			NDO Required to be Normally Closed?	Direction of Air Flow (One Hour Verification)						
	Open	Closed	Into Enclosure	Out of Enclosure	Swirled		Initial:	10 min:	20 min:	30 min:	40 min:	50 min:	60 min:
							Actual Time:	Actual Time:	Actual Time:	Actual Time:	Actual Time:	Actual Time:	Actual Time:

***Check to verify that airflow was checked at top, bottom, middle, and both sides of enclosure.**

Status of doors and windows
Are all access doors and windows whose areas are not included as NDOs closed during normal operation.
☐ Yes ☐ No

Capture of VOC Emissions
Does all exhaust ductwork go to control (for PTE) or to a point where it can be measured (for TTE).
☐ Yes ☐ No

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Volumetric Air Flow Calculations (Wet Bulb/ Dry Bulb)

$$Bws = \left[\frac{e' - AP(t - t')}{P} \right]$$

$e' =$ saturated vapor presssure of water, in.Hg,
at the wet bulb temperature, t'

$A = 3.67 \times 10^{-4} \left[1 + 0.00064 (t' - 32) \right]$

$P =$ pressure, inches mercury, in the duct

$t =$ dry bulb temperature, $^\circ F$

$t' =$ wet bulb temperature, $^\circ F$

$Bws =$ water vapor in gas stream proportion
by volume

$$Md = (0.44 \times \%CO_2) + (0.32 \times \%O_2) + \left[0.28 \times (100 - \%CO_2 - \%O_2) \right]$$

$$MS = Md \times (1 - Bws) + (18 \times Bws)$$

$$Vs = \sqrt{\frac{(Ts + 460)}{Ms \times Ps}} \times \sqrt{DP} \times Cp \times 85.49$$

$$Acfm = Vs \times \text{Area (of stack or duct)} \times 60$$

$$Dscfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right] \times (1 - Bws)$$

$$Scfm = Acfm \times 17.647 \times \left[\frac{Ps}{(460 + Ts)} \right]$$

$$Scfh = Scfm \times 60 \frac{min}{hr}$$

acfm = actual cubic feet per minute
dscfm = dry standard cubic feet per minute
scfm = standard cubic feet per minute
scfh = standard cubic feet per hour

Cp	=	pitot tube correction factor
Ps	=	absolute flue gas pressure
Ms	=	molecular weight of gas (lb/lb mole)
Md	=	dry molecular weight of gas (lb/lb mole)

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MOISTURE CALCULATIONS

$$V_{wc(std)} = \frac{(V_f - V_i)\,\rho_w\,R\,T_{std}}{P_{std} M_w} = 0.04707(V_f - V_i)$$

$$V_{wsg(std)} = \frac{(W_f - W_i)\,R\,T_{std}}{P_{std}\,M_w} = 0.04715\,(W_f - W_i)$$

$$V_{m(std)} = 17.64\;V_m\;Y\,\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}$$

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}}$$

Where:

B_{ws} =	Water vapor in gas stream, proportion by volume
M_w =	Molecular weight of water, 18.015 lb/lb-mole
P_{bar} =	Barometric pressure at the testing site, in. Hg
P_{std} =	Standard absolute pressure, 29.92 in. Hg
R =	Ideal gas constant, 0.048137 (in. Hg)(ft^3)/(g-mole)(°R) = [21.8348(in. Hg)(ft^3)/(lb-mole)(°R)]/453.592 g-mole/lb-mole
T_m =	Absolute average dry gas meter temperature, °R
T_{std} =	Standard absolute temperature, 528 °R
V_f =	Final volume of condenser water, ml
V_i =	Initial volume of condenser water, ml
V_m =	Dry gas volume measured by dry gas meter, dcf
$V_{m(std)}$ =	Dry gas volume measured by dry gas meter, corrected to standard conditions, scf
$V_{wc(std)}$ =	Volume of condensed water vapor, corrected to standard conditions, scf
$V_{wsg(std)}$ =	Volume of water vapor collected in silica gel, corrected to standard conditions, scf
W_f =	Final weight of silica gel, g
W_i =	Initial weight of silica gel, g
Y =	Dry gas meter calibration factor
ΔH =	Average pressure exerted on dry gas meter outlet by gas sample bag, in. H_2O
ρ_w =	Density of water, 0.9982 g/ml
13.6 =	Specific gravity of mercury (Hg)
17.64 =	T_{std}/P_{std}
0.04707 =	ft^3/ml 0.04715 = ft^3/g

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ppmv to lb/hr Conversion Calculations

1. $$\text{ppm } SO_2 \times 1.660 \times 10^{-7} = \frac{\text{lbs}/SO_2}{\text{scf}}$$

$$\frac{\text{lbs}SO_2}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{min}}{\text{hr}} = \frac{\text{lbs}SO_2}{\text{hr}}$$

2. $$\text{ppm}NO_x \times 1.194 \times 10^{-7} = \frac{\text{lbs}/NO_x}{\text{scf}}$$

$$\frac{\text{lbs}NO_x}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{min}}{\text{hr}} = \frac{\text{lbs}NO_x}{\text{hr}}$$

3. $$\text{ppm } CO \times 7.266 \times 10^{-8} = \frac{\text{lbs}/CO}{\text{scf}}$$

$$\frac{\text{lbs } CO}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{ min}}{\text{hr}} = \frac{\text{lbs } CO}{\text{hr}}$$

4. $$\text{ppm } C_3H_8 \times 1.142 \times 10^{-7} = \frac{\text{lbs}C_3H_8}{\text{scf}}$$

$$\frac{\text{lbs}C_3H_8}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{min}}{\text{hr}} = \frac{\text{lbs}C_3H_8}{\text{hr}}$$

5. $$\text{ppm } CH_4 \times 4.164 \times 10^{-8} = \frac{\text{lbs}CH_4}{\text{scf}}$$

$$\frac{\text{lbs}CH_4}{\text{scf}} \times \frac{\text{scf}}{\text{min}} \times \frac{60\text{min}}{\text{hr}} = \frac{\text{lbs}CH_4}{\text{hr}}$$

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Procedures for Calibration

Temperature Sensing Devices

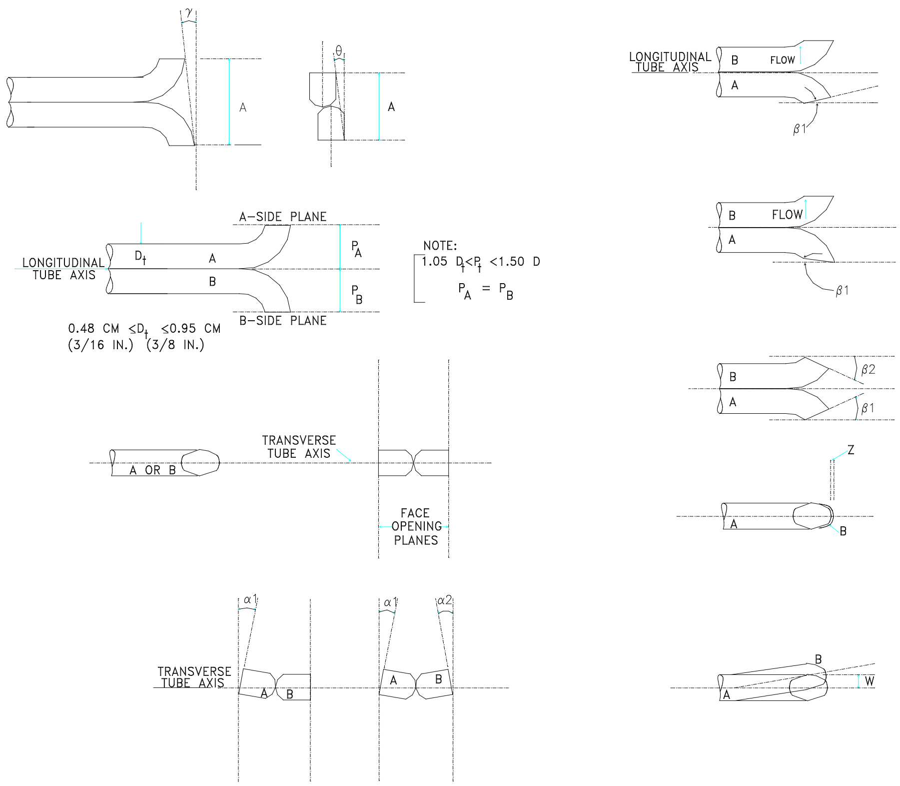
The potentiometer and thermocouples are calibrated utilizing a NBS traceable millivolt source.

Pitot Tubes

The pitot tubes utilized during this test program are manufactured according to the specification described and illustrated in the *Code of Federal Regulations*, Title 40, Part 60, Appendix A, Methods 1 and 2. The pitot tubes comply with the alignment specifications in Method 2, Section 4; and the pitot tube assemblies are in compliance with specifications in the same section.

S TYPE PITOT TUBE INSPECTION FORM

Pitot Tube No: 1 Date: 10/10/2011 Inspectors Name: DTEM



Pitot tube assembly level? x yes ____ no

Pitot tube openings damaged? ____ yes (explain below) x no

a_1 = 1 ^{o} (<10^o), a_2 = 1 ^{o} (<10^o) z = A sin g = 0.008 (in.); (<0.125 in.)

b_1 = 0 ^{o} (<5^o), b_2 = 2 ^{o} (<5^o) w = A sin q = 0.025 (in.); (<0.03125 in.)

γ = 0.5 ^{o}, θ = 1.5 ^{o}, A = 0.938 (in.) P_A = 0.477 (in.), P_B = 0.477 (in.), D_t = 0.375 (in.)

Calibration required? ____ yes x no

Dry Gas Meter No.	CM1	Date:	December 28, 2011
Standard Meter No.	16745468	Calibrated By:	BWH
Standard Meter (Y)	1.0000	Barometric Pressure:	29.65

Run Number		Orifice Setting in H_2O Chg (H)	Standard Meter Gas Volume vr	Dry Gas Meter Gas Volume vd	Standard Meter Temp. F° tr	Dry Gas Meter Inlet Temp. F° tdi	Dry Gas Meter Outlet Temp. F° tdo	Dry Gas Meter Avg. Temp. F° td	Time Min	Time Sec	Y	Chg (H)
Final			35.289	61.905	59	62	62					
Initial			29.196	55.737	59	62	62					
Difference	1	0.20	6.093	6.168	59	62	62	62	21	30	0.993	1.373
Final			41.434	68.107	59	63	62					
Initial			35.447	62.063	59	62	61					
Difference	2	0.50	5.987	6.044	59	63	62	62	13	0	0.995	1.300
Final			47.503	74.269	58	64	62					
Initial			41.698	68.395	59	63	62					
Difference	3	0.70	5.805	5.874	59	64	62	63	10	50	0.995	1.340
Final			53.142	79.947	58	65	62					
Initial			47.691	74.437	59	64	62					
Difference	4	0.90	5.451	5.510	59	65	62	63	9	0	0.996	1.347
Final			58.938	85.809	58	63	62					
Initial			53.202	80.108	59	64	62					
Difference	5	1.20	5.736	5.701	59	64	62	63	7	45	1.011	1.204
Final			29.095	55.645	59	63	62					
Initial			23.404	49.895	59	62	62					
Difference	6	2.00	5.691	5.750	59	63	62	62	6	30	0.991	1.438

Average	**0.997**	**1.333**

Stack Temperature Sensor Calibration

Meter Box # : *CM1*

Name : *BWH*

Ambient Temperature : *59* ^oF

Date : *December 28, 2011*

Calibrator Model # : *CL23A*

Serial # : *T-276953*

Date Of Certification : *January 11, 2011*

Primary Standards Directly Traceable National Institute of Standards and Technology (NIST)

Reference Source Temperature (^oF)	***Test Thermometer Temperature (^oF)***	***Temperature Difference %***
0	*0*	0.0
250	*249*	0.0
600	*599*	0.0
1200	*1201*	0.0

$$\frac{(\text{Ref. Temp.}, ^oF + 460) - (\text{Test Therm. Temp.}, ^oF + 460)}{\text{Ref. Temp.}, ^oF + 460} * 100 <= 1.5\ \%$$

Method 25A Calibration Summary

Project:	______	Date:	______
Client:	______	Operator:	______
Location:	______	Analyzer ID:	______
		Analyzer Range:	______

Cal Run	Cal Level	Test Location	Cylinder ID Serial Number	Cal Gas Type	Cal Time	Expected Cal Value	Actual Response	Difference (% of cal value)	Drift (% of span)	Cylinder Pressure
Pre 1	Zero								N/A	
	Low								N/A	
	Mid								N/A	
	High								N/A	
Post 1/ Pre 2	Zero									
	Low									
	Mid									
	High									
Post 2/ Pre 3	Zero									
	Low									
	Mid									
	High									
Post 3	Zero									
	Low									
	Mid									
	High									
	Zero									
	Low									
	Mid									
	High									
	Zero									
	Low									
	Mid									
	High									

CALIBRATION SUMMARY

Project Number: ______________________ Date: ______________________

Client: ______________________ Operator: ______________________

Test Location: ______________________ Box Truck: ______________________

Analyzer Type, S/N, and Span	Cal Level	Cylinder ID Serial Number	Expected Cal Value	Actual Response	Difference As % of Span	Cylinder Pressure (psi)	Cylinder Expiration Date
NO_x	Zero						
	Mid						
	High						
CO_2	Zero						
	Mid						
	High						
O_2	Zero						
	Mid						
	High						